



Remember when  
the sky was the limit?

# Translate MultiCore Power into Application Performance

**Intel® Software  
Development  
Products Overview  
Vadim Roussin  
Business Development  
Manager, EMEA**



# Agenda

Introduction

Multi-core processors change the rules

Intel® Software Development Products overview

- Introducing Intel® Threading Building Blocks

Conclusion and next steps



# Multi-core Processors change the rules

*Until recently....*

**Faster software came from faster processors**

**Those days are gone**

**Now performance will primarily  
come from multi-core processors**

**Get your software ready for multi-core using Intel® Tools**



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Intel® Software Development Products Overview

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# Maximize Multi-Core Performance By Parallelizing Software

Parallelism is achieved at the application level by software threading, implementing MPI clusters or a combination of both

- Breaks problem into pieces that can be solved in parallel
- Performance can scale with number of processors

Need tools to architect, introduce, debug and tune parallelized applications

Architectural  
Analysis



Introducing  
Parallelism



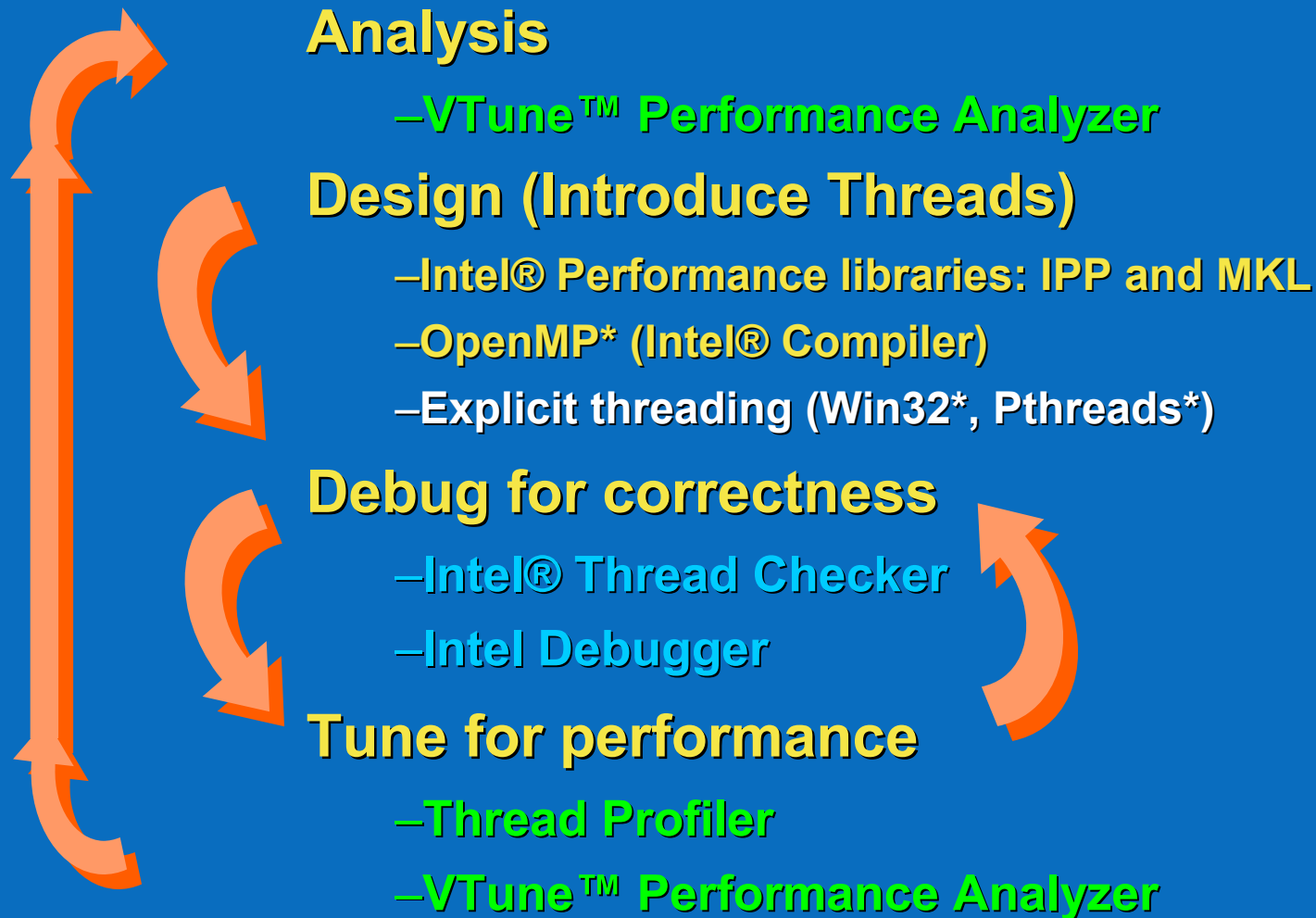
Debugging

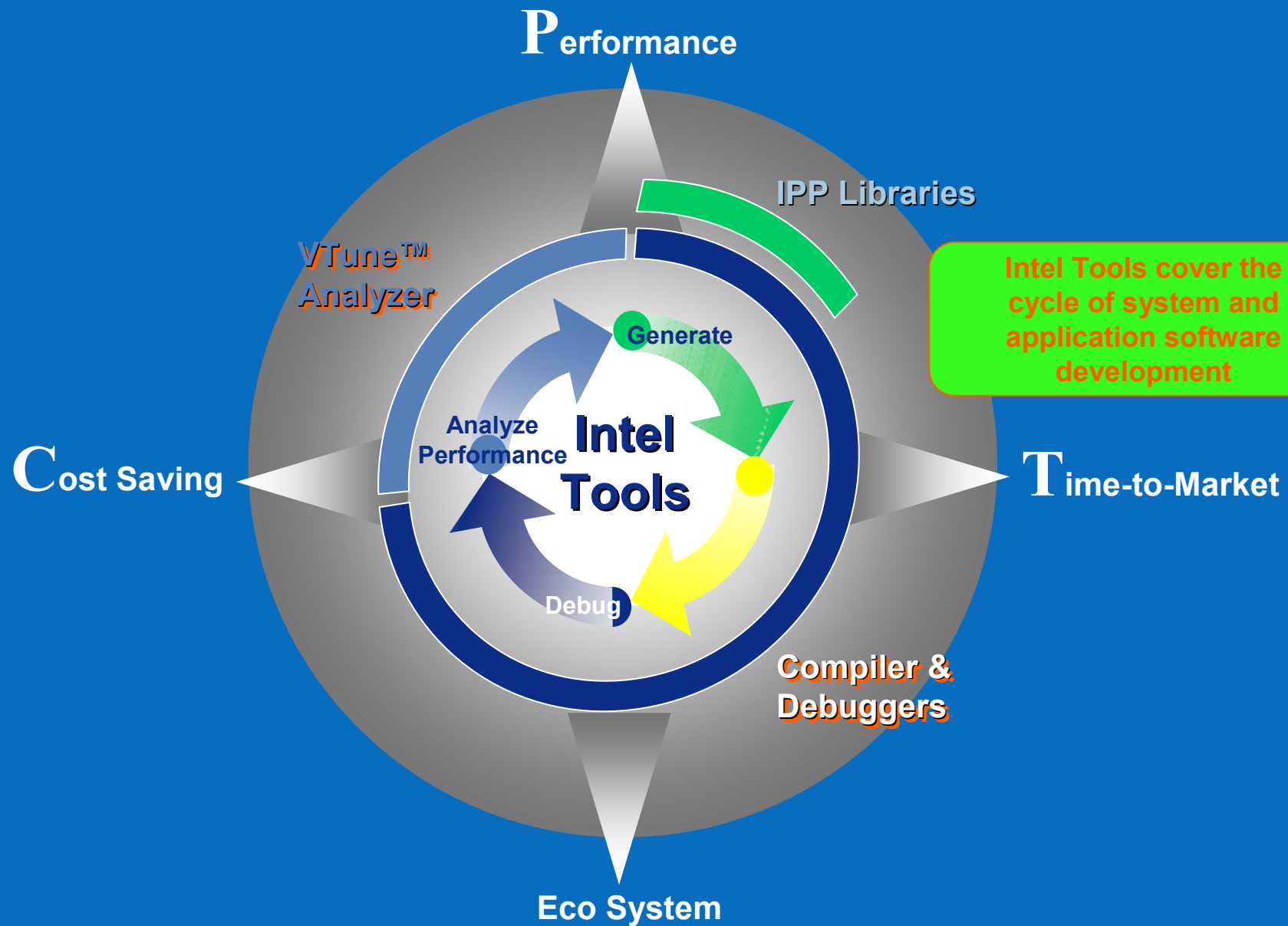


Performance  
Tuning



# A Generic Development Cycle





# Parallelize with Intel® Software Development Products

[Click Here  
to See  
Platform  
Support](#)

## Intel® Compilers

- The best way to get application performance on Intel® processors

## Intel® VTune™ Performance Analyzers

- Identify bottlenecks in source code and optimize multi-core performance

## Intel® Performance Libraries

- Highly optimized, thread-safe, multimedia and HPC math functions

## Intel® Threading Analysis Tools

- Find threading errors and optimize threaded applications for maximum performance

## Intel® Threading Building Blocks

- C++ template-based runtime library that simplifies writing multithreaded applications for performance and scalability

## Intel® Cluster Tools














































- Create, analyze, optimize and deploy cluster-based applications

## Cluster Open MP

- Runs (slightly modified) OpenMP codes on a commodity cluster



# Cross Platform Support – From Servers to Cell Phones

Intel® Software Development Products				    				
Currently Available 		Operating Systems Windows* Linux*		Operating Systems Windows Linux Mac OS*				
		Development Environments Visual Studio* GCC*		Development Environments Visual Studio GCC Xcode*				
Compilers	C++							
	Fortran							
Performance Analyzers	VTune™ Performance Analyzer							
Performance Libraries	Integrated Performance Primitives							
	Math Kernel Library							
	Mobile Platform SDK							
Threading Analysis Tools	Thread Checker							
	Thread Profiler							
Cluster Tools	MPI Library							
	Trace Analyzer and Collector							
	Math Kernel Library Cluster Edition							
	Cluster Toolkit							

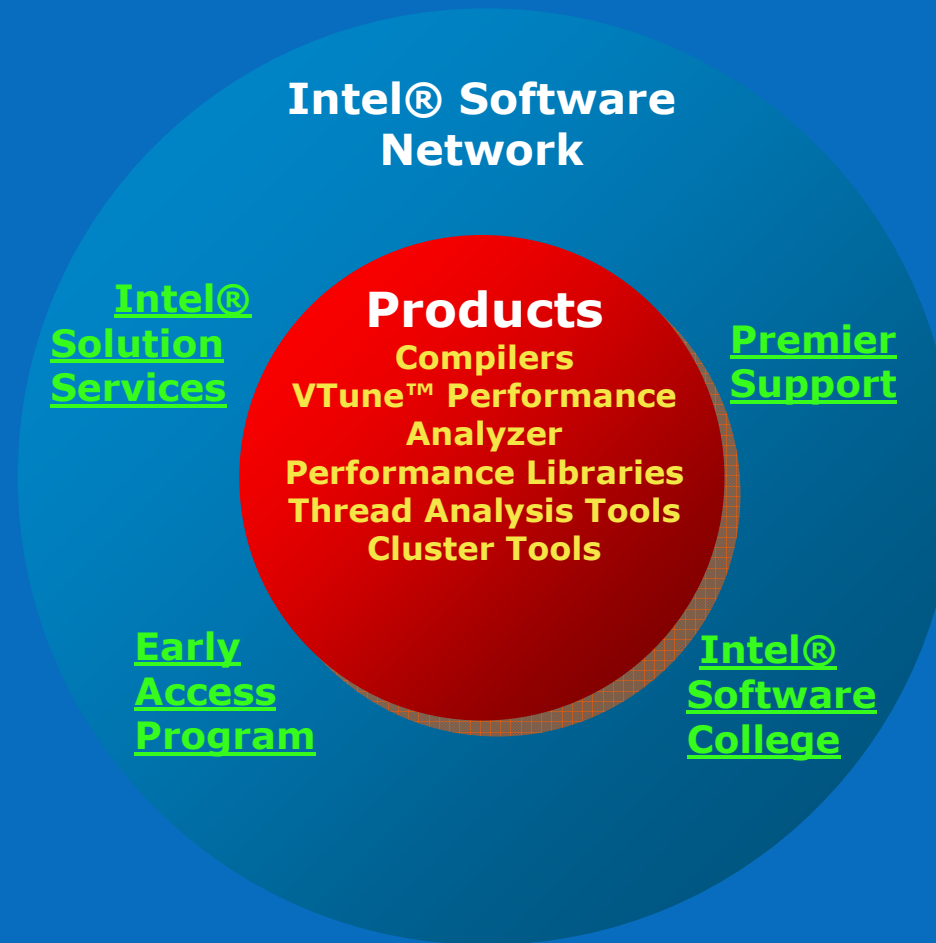
Intel also offers software development products for PDAs and mobile phone solutions that use Intel® Personal Internet Client Architecture (Intel® PCA) processors with Intel XScale® technology.

**From Servers to Mobile / Wireless Computing, Intel® Software Development Products Enable Application Development Across Intel® Platforms**





# Why Intel® for Software Development?



**Intel Offers a Complete Solution of Software Development Products, Training and Support Services for Software Developers**



# Intel® Software Development Products enable you to harness the power of your software to unleash the full potential of Intel® hardware

- **Performance**

- Extract the maximum application performance from Intel® based systems
- Simplify taking advantage of capabilities such as multi-core and Intel® EM64T

- **Compatibility**

- Compatible with popular development environments including Microsoft Visual Studio on Windows\*, GCC on Linux\* and Xcode\* on Mac OS\*
- 32-bit and 64-bit processor support with one package

- **Support**

- Unlimited technical support and upgrades included for one year
- Get answers from the engineers who develop software on Intel® Architecture



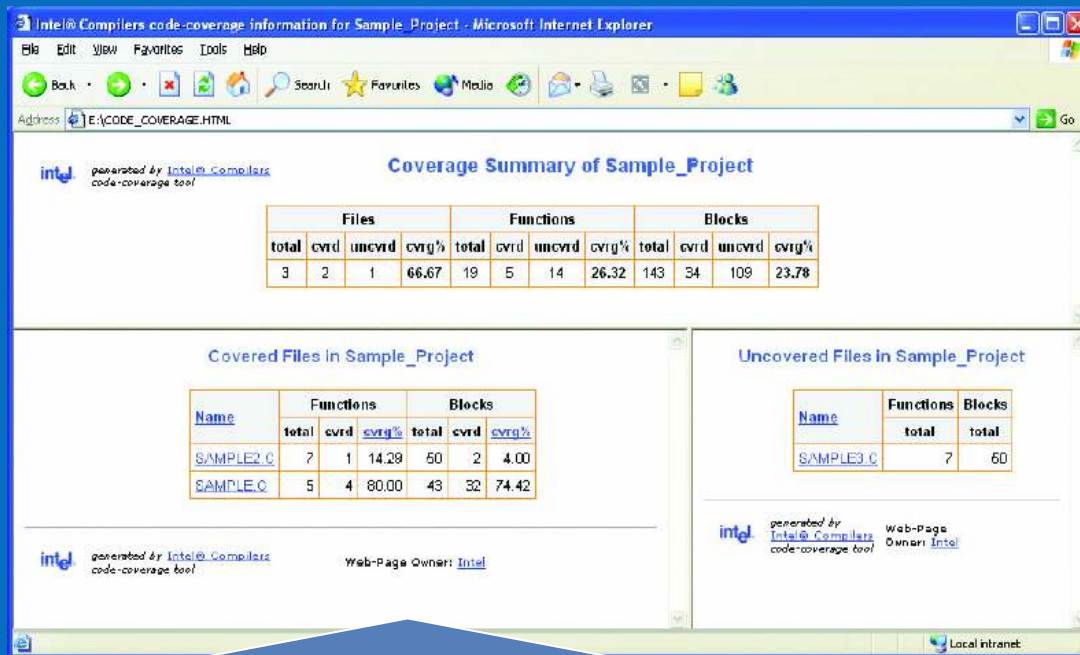
# Intel® C++ and Fortran Compilers

- Multi-threading support
  - Auto-parallelization and OpenMP\* support
- Mac OS\* support
  - XCode\* Integration - Command line, source, and binary compatibility with GCC 4.0/G++
  - Universal Binaries supported
- Windows\* support
  - Plug-in compatibility with Microsoft Visual Studio\* (98 (C/C++ only), 2002/ 2003/ 2005)
  - Native source and object code compatibility with Microsoft Visual C++\*
  - Source compatibility with Compaq Visual Fortran\*
- Linux\* support
  - Command line compatibility with GCC (C++ Linux)
  - Source and binary compatibility with GCC 3.2/ 3.3/ 3.4/ 4.0
  - Integration with Eclipse\* 3.1.1/CDT 3.0 (IA-32 & Itanium® 2 processors)
- Intel® processor support
  - Support for Streaming SIMD Extensions (SSE2, SSE3)
  - Latest Intel 32-bit, Intel® EM64T, Itanium 2, and Multi-core processors.
  - Support for AMD\* processors such as AMD Opteron\* and Athlon\*
- Intel® Code Coverage & Intel® Test Prioritization Tools

"The Intel C++ Compiler for Linux provided to Fluent's Computational Fluid Dynamics (CFD) software an **impressive 9% to 37% performance improvement** over the GNU C compiler, when we ran our standard benchmarks. The Intel C++ Compiler for Linux integrated smoothly into our development environment, with no technical issues." — **Dr. Dipankar Choudhury, CTO, Fluent Inc.**



# Intel® Code Coverage Tool



Clicking on SAMPLE.C produces highlighted listing of exercised code.

- Pink: never exercised
- Yellow: part in a covered function that was not exercised by any tests
- Beige: partially covered

**Example Code Coverage Summary:**  
Workload exercised 34 of 143 blocks, representing 5 of 19 functions in 2 of 3 modules. In SAMPLE.C, 4 of 5 functions were exercised



# Intel® Test Prioritization Tool

Helps guide and speed software testing,

- Helps produce better code more quickly
- Helps improve programmer productivity

Example:

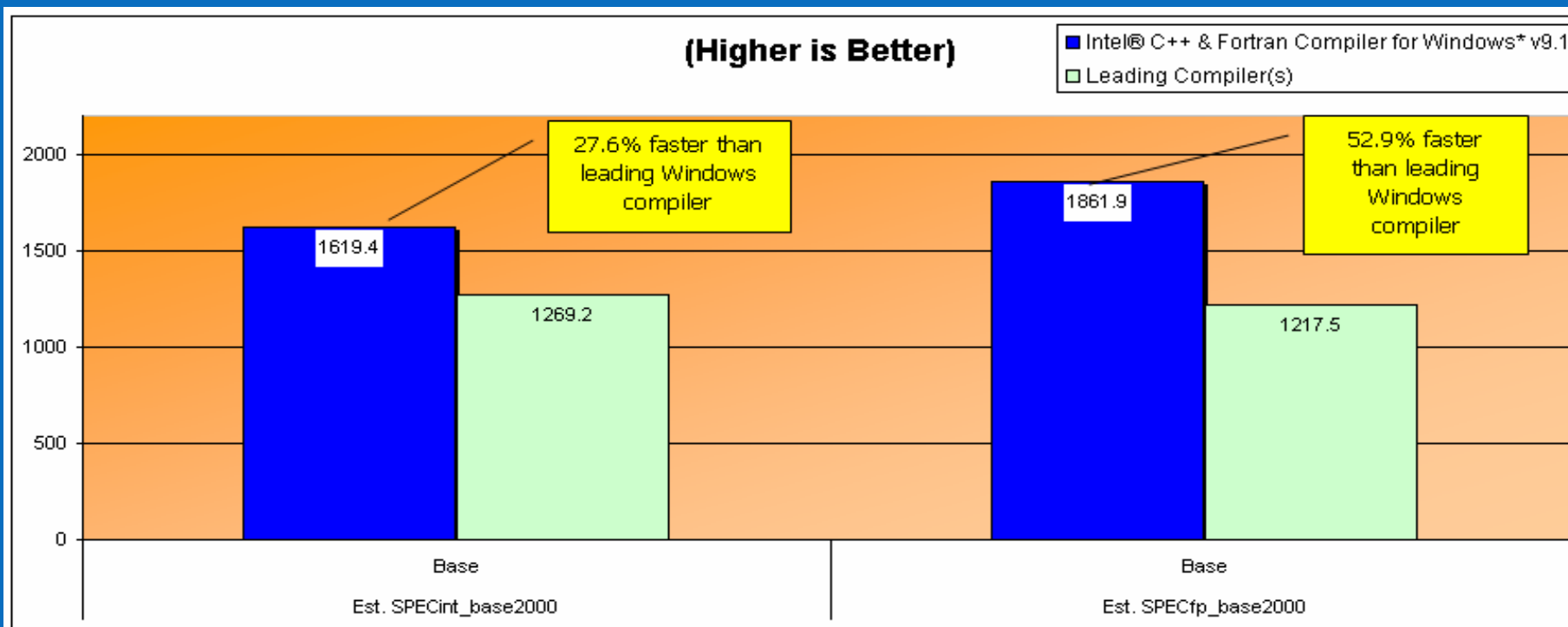
- Initially, 3 tests achieved 52.17% block and 50.00% function coverage

Number of Tests	%Rat Cvrg	%Blk Cvrg	%Func Cvrg	Test Names @ Options
1	87.50	45.65	37.50	Test3.dpi
2	100.00	52.17	50.00	Test2.dpi
Total Number of Tests = 3				
Total Block Coverage ~ 52.17%				
Total Function Coverage ~50.00%				

- Test 3 alone covers 45.65% of basic blocks (which is 87.50% of total block coverage from all tests)
- By adding Test 2, cumulative block coverage goes to 52.17%, or 100% of the total block coverage of Test 1, Test 2, and Test 3
- Eliminating Test 1 (not shown) has no negative impact on block coverage and saves time



# Est. SPEC\* CPU2000 V1.2, IA-32, Windows\*



## Configuration Info

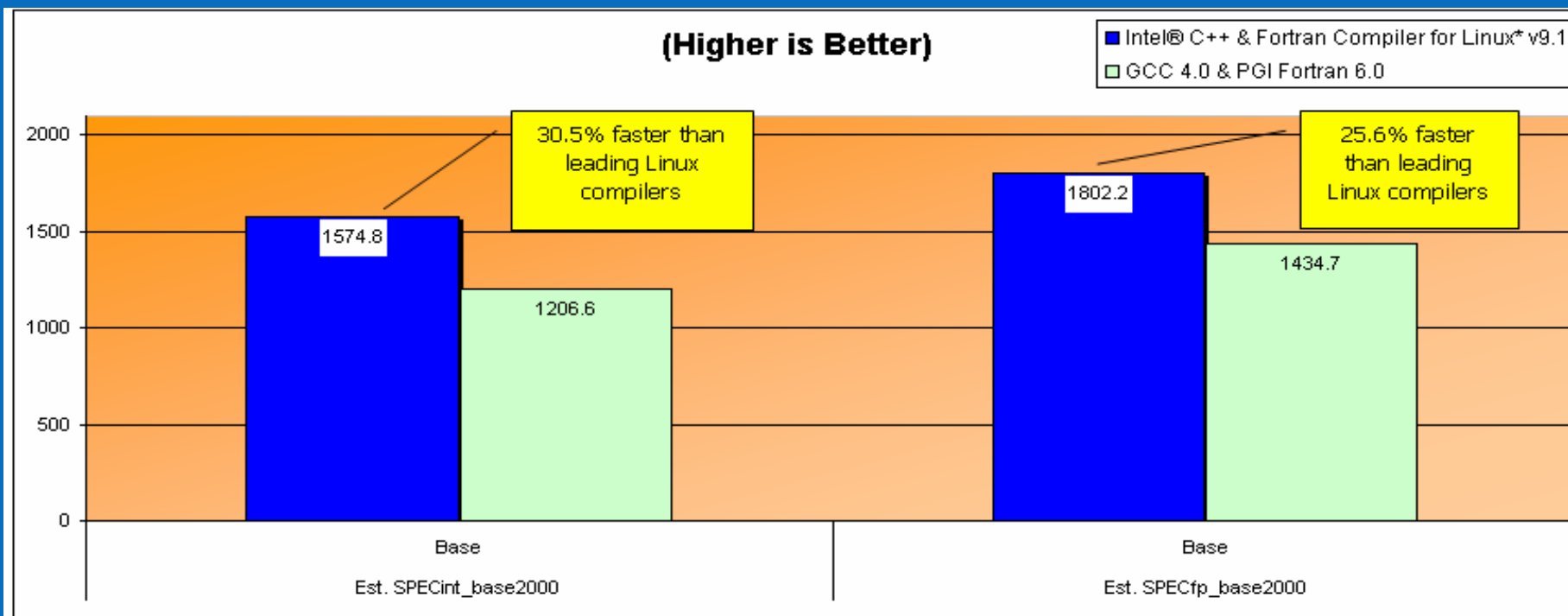
- For more information about the SPEC int2000 benchmark, visit [www.spec.org/cpu2000/](http://www.spec.org/cpu2000/)
- Compilers: Intel® C++ Compiler 9.1 for Windows\*, Intel® Visual Fortran Compiler 9.1, Standard Edition, for Windows, Microsoft® Visual C, C++ 7.1, Compaq Visual Fortran® 6.6C, Absoft 9.0
- Hardware & OS: Intel® Pentium® 4 Processor, 3.6 GHz., 2 GB, 1MB L2, Operating System: MS Windows Server 2003 Enterprise Edition, Build 3790

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, refer to [http://www.intel.com/performance/resources/benchmark\\_limitations.htm](http://www.intel.com/performance/resources/benchmark_limitations.htm).



# Est. SPEC\* CPU2000 V1.2, IA-32, Linux\*

Intel®  
Compiler  
Performance  
Indicators



## Configuration Info

- For more information about the SPEC int2000 benchmark, visit [www.spec.org/cpu2000/](http://www.spec.org/cpu2000/)
- Compilers: Intel® C++ Compiler 9.1 for Linux\*, Intel® Fortran Compiler 9.1 for Linux\*, GCC 4.0 & PGI Fortran 6.0
- Hardware & OS: Intel® Pentium® 4 Processor, 3.6 GHz., 512 MB, 1 MB L2, Operating System: Linux, kernel 2.4.21-20.EL #1, glibc 2.3.2-95.30

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, refer to [http://www.intel.com/performance/resources/benchmark\\_limitations.htm](http://www.intel.com/performance/resources/benchmark_limitations.htm).



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Intel® Software Development Products Overview

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# Intel® VTune™ Performance Analyzer

Quickly find application bottlenecks

- Multi-threading support
  - Tune multi-core sharing of the bus & cache
  - Balance loads & reduce idle time
- Multiple techniques to gather tuning data
  - Sampling – locates bottleneck with < 5% overhead
  - Call Graph – identifies calling sequence, loop counts
- Support for Java\* and .NET\*

Windows\* NT, Vista, Visual Studio\* 2005

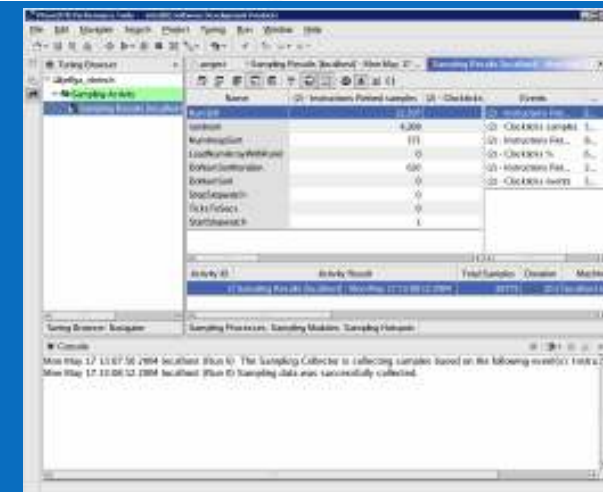
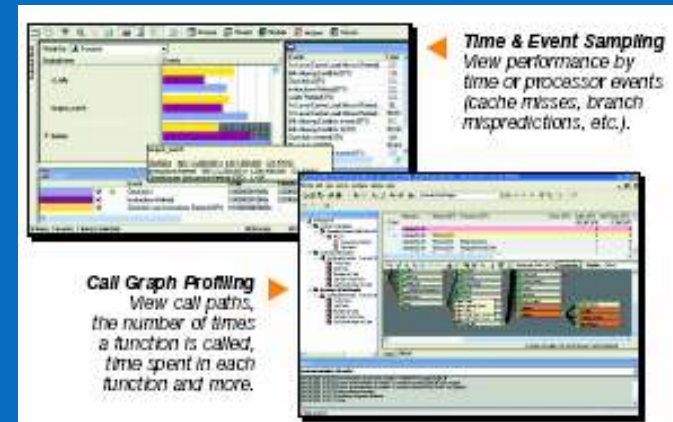
- Full 32 and 64-bit profiling support
- Powerful graphical analysis
- Remote agents for profiling Linux\* and Intel® XScale® processor platforms

Native Linux\* for many popular distributions

- Eclipse based GUI
- Flexible command line interface

**"The improved Eclipse GUI in VTune analyzer has made it much easier and much quicker to identify problem areas in the application codes."**

**— Donny Cooper, Senior Systems Analyst, NEC Solutions (America) Inc.**





# Intel® Threading Building Blocks 1.0

## Scalable Threads Faster

### Description

- Intel's new C++ template-based runtime library that simplifies writing multithreaded applications for performance and scalability

### Key Benefits

- Ready to use parallel algorithms that easily plug into applications and deliver scalable performance
- Highly concurrent containers for robust threaded applications
- Task based parallelism to abstract platform details and focus on application
- Library based solution that seamlessly integrates into development environments
- Cross platform support speeds deployment of applications on various multi-core platforms
- Supports 32-bit and 64-bit platforms using Intel®, Microsoft\* and GNU\* compilers
- Support for Windows\*, Linux\* and Mac OS X\*



# Intel® Thread Checker 3.0 for Windows\*

## Create Threads Faster

### Key Benefits

- Detects challenging data races and deadlocks
- Pinpoints errors to the source code line
- Works on standard debug builds without recompiling
- Recommends modules to instrument by usage (minimize instrumentation overhead)
- Scriptable interface for test environment integration (enabling batch file runs)
- Supports 32 and 64-bit applications
- Supports Microsoft Visual Studio 2005



**New**

**New**

**New**

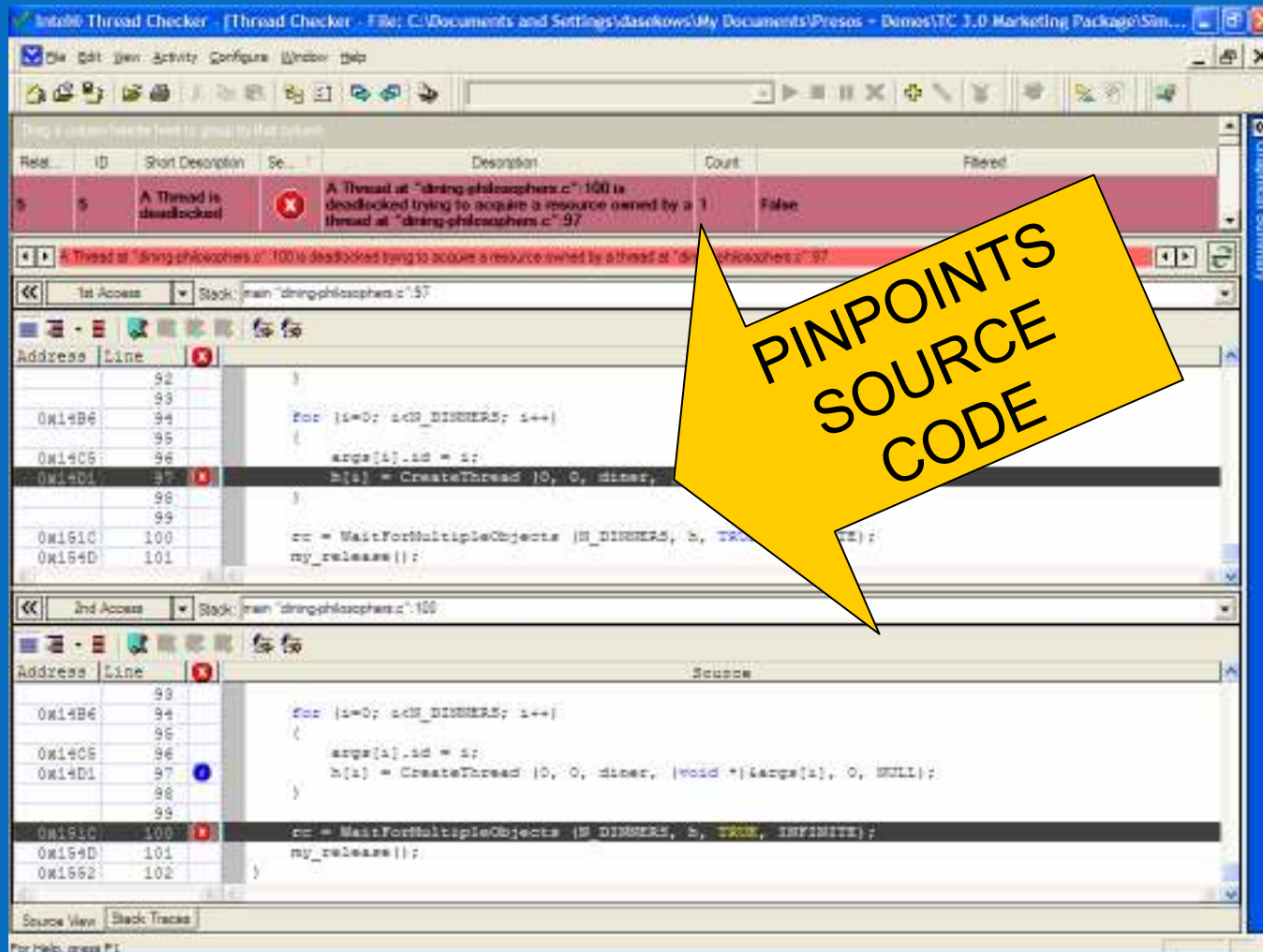
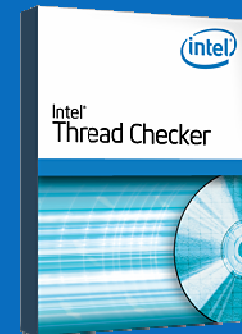
**Intel's Thread Checker helped identify potential threading issues very quickly, in days compared to weeks if done otherwise.**

*Dana Batali  
Director of RenderMan Development  
Pixar*



# Intel® Thread Checker for Windows\*

## Pinpoints notorious threading bugs



# Intel® Thread Checker 3.0 for Linux\*

## Create Threads Faster

### Key Benefits

- Detects challenging data races and deadlocks
- Pinpoints errors to the source code line
- Supports 32-bit and 64-bit applications
- Works on standard debug builds without recompiling
- Introduction of native Linux\* support through command line views
- Easy integration into batch scripts for use in nightly regression test runs








```
Intel(R) Thread Checker 3.0 command line
Copyright (c) 2006 Intel Corporation. All rights reserved.
```

ID	Short Description	Severity Name	Count	Context [Best]	Description
1	A Thread is stalled	Warning	1	Whole Program 1	A Thread at line 1 by a thread
2	A Thread is stalled	Warning	1	Whole Program 2	A Thread at line 2 by a thread
3	A Thread is stalled	Warning	1	Whole Program 3	A Thread at line 3 by a thread
4	A Thread is deadlocked	Error	1	Whole Program 4	A Thread at line 4 in philosophers.c



# Intel® Thread Checker & Intel® Thread Profiler v3.0 Expanded Platform Support

OS	Architecture	Application	Instrumentation	Intel® Thread Checker		Intel® Thread Profiler	
				Native Threads <sup>3</sup>	OpenMP <sup>4</sup>	Native Threads <sup>3</sup>	OpenMP <sup>4</sup>
Windows*		32-bit	Compiler <sup>1</sup>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary <sup>2</sup>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		32-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		64-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Linux* <sup>5</sup>		32-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		32-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		64-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
		64-bit	Compiler	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
			Binary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<sup>1</sup> Compiler: Refers to using the Intel® Compilers with a command line switch selected during a recompile that does source instrumentation and, when using Intel® Threading Tools, allows you to see down to the variable along the source code line.

<sup>2</sup> Binary: refers to using an Intel, Windows, or GNU compiler to take an existing application, without the need to recompile, and run the Intel Threading Tools to give you a certain amount of information at the source code level.

<sup>3</sup> Native Threads: Refers to Windows Threads or POSIX threads (Linux\*)

<sup>4</sup> Intel® Itanium® Processors requires use of Intel® Compilers

<sup>5</sup> Intel® Thread Profiler supports Linux\* applications via a Remote Data Collection (RDC) from a Windows host system

\* Other brands and names are the property of their respective owners.

# Intel® Thread Profiler 3.0 for Windows\*

## Optimize Threads Faster

### Key Benefits

- Shows how much of your application is not optimally parallel and where
- Identifies where thread specific overhead impacts performance
- Highlights thread workload imbalances and thread activity
- Shows the number of cores utilized
- Pinpoints issues to the source code line
- Maximizes application time spent in parallel regions
- Supports 32 and 64-bit applications
- Supports Microsoft Visual Studio 2005

**New**

**New**



*"Intel ThreadProfiler was very useful for analyzing bottlenecks in our threaded code."*

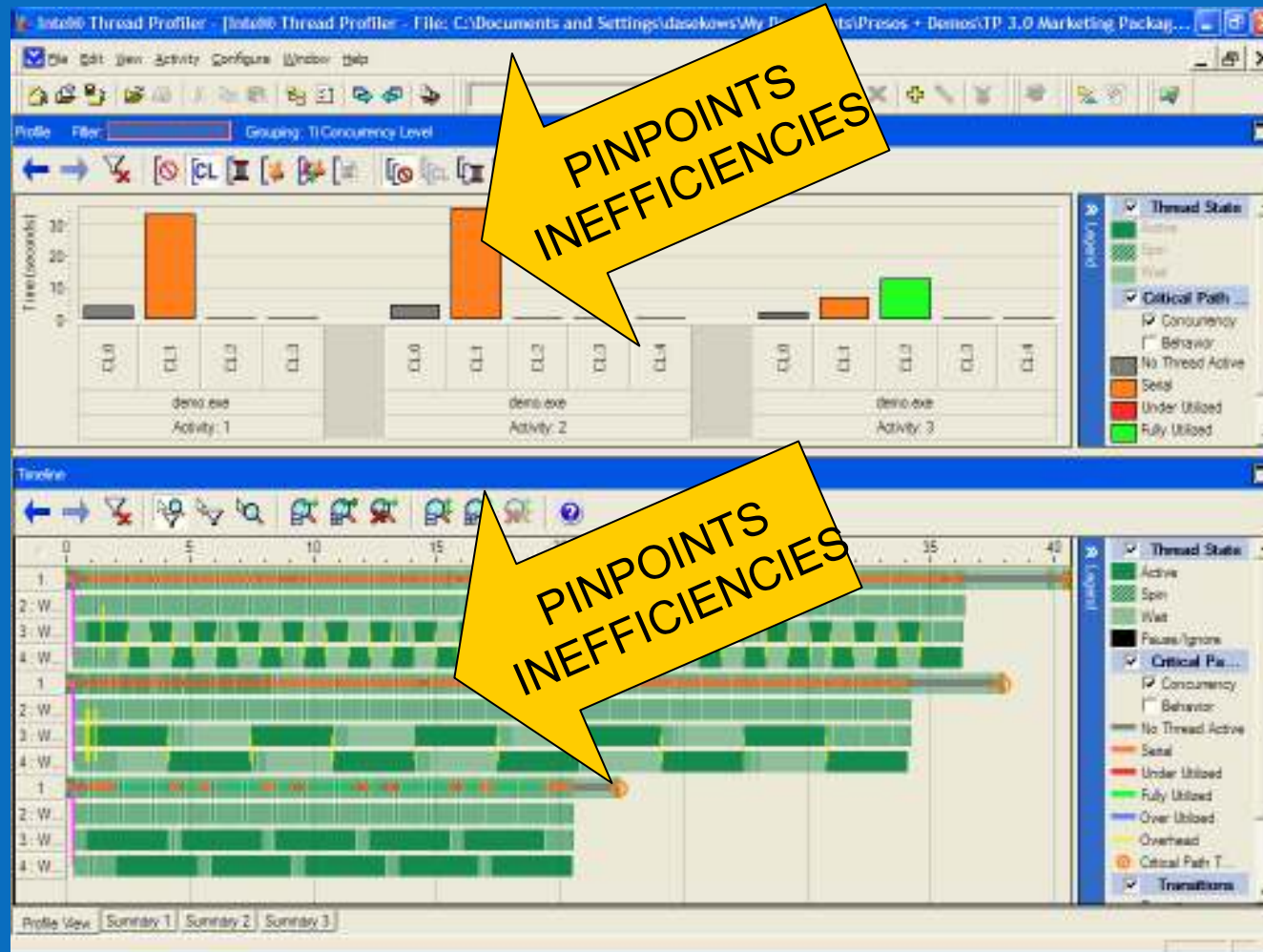
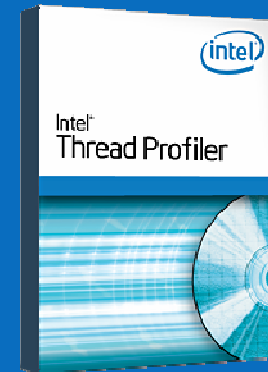
*Martin Watt, Software Architect, Alias*





# Intel® Thread Profiler

## Pinpoints threading inefficiencies



# Intel® Performance Libraries

## Intel® Integrated Performance Primitives

- Library of highly optimized functions for imaging, audio, video, speech, vision, data compression, cryptography and signal processing
  - Ideal for real-time applications

## Intel® Math Kernel Library

- Highly optimized math functions for scientific, engineering and financial applications
  - BLAS & LAPACK
  - Sparse Solvers
  - Fast Fourier Transforms
  - Vector Math
  - Random Number Generators

## Intel® Math Kernel Library Cluster Edition

- All the functions in the Intel® Math Kernel Library plus ScaLAPACK and distributed memory FFTs

"People want to have the ability to view good quality, high-resolution video from their own desk or on the move. For ImageCom, providing targeted applications that are specifically optimized with Intel® IPP and C++ compiler is crucial to enabling this."

— Thomas Dove – CEO, Imagecom, Inc.

"The performance increase from simply using the Intel Math Kernel Library (Intel MKL), with its threading capabilities, was amazing. We are more than delighted with the results."

— Gavin Lavelle – President, Panorama

**Write once, realize performance over many processor generations**





# Intel® Math Kernel Library ScaLAPACK Performance

“Scalable LAPACK” or LAPACK for distributed memory computer systems

NETLIB\* - Standard publicly available implementation of ScaLAPACK

Chart Shows

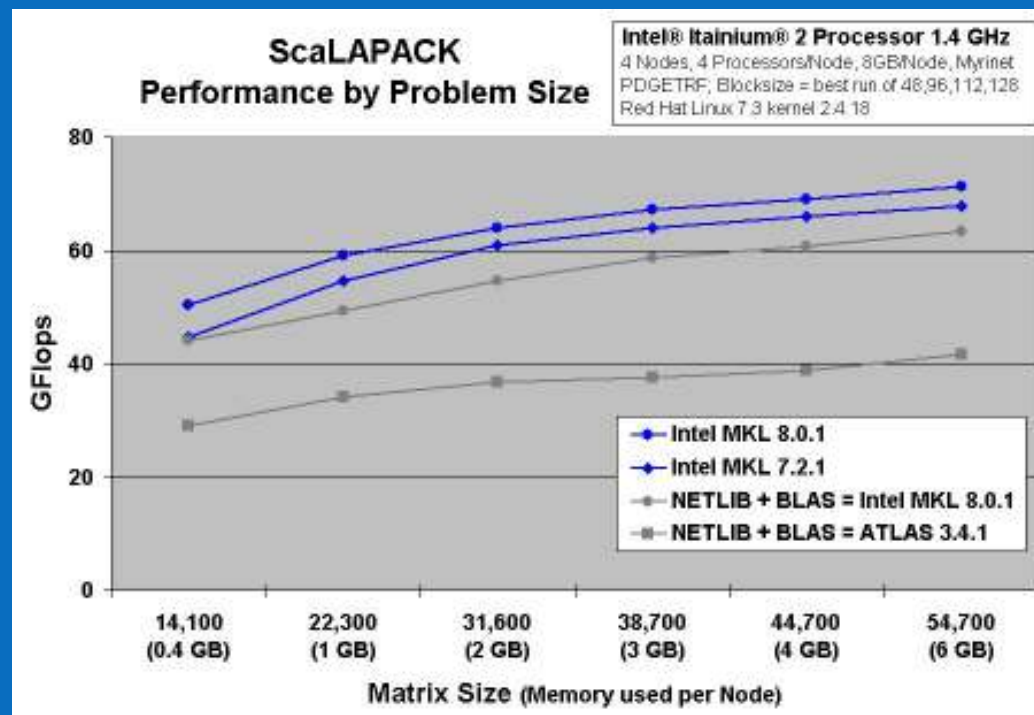
Intel® MKL 8.0.1 is ~7% improvement over Intel® MKL 7.2.1

Intel® MKL has significant ScaLAPACK-specific optimizations

- Comparing Intel® MKL 8.0.1 to NETLIB using BLAS from Intel® MKL shows ~15% speedup from ScaLAPACK specific optimizations

Intel® MKL 8.0.1 is much faster than NETLIB using ATLAS\* BLAS

- >50% faster

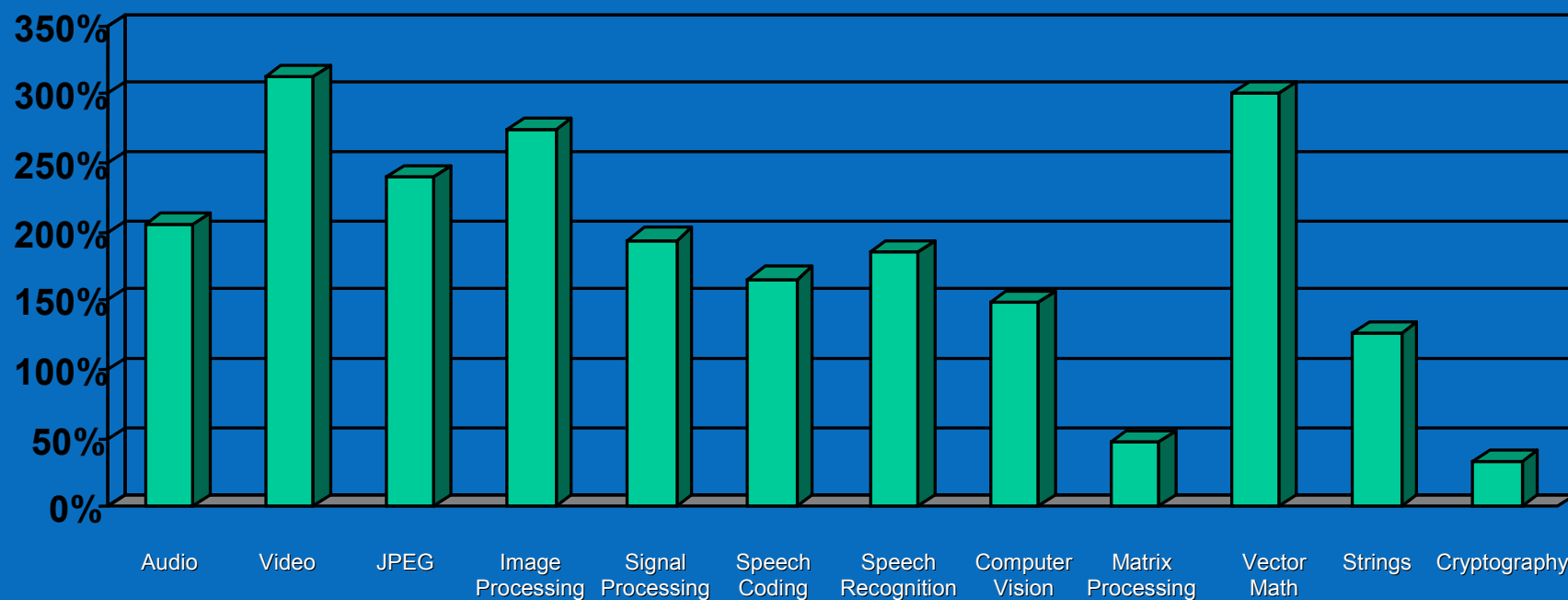


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# Intel® IPP Performance

Average Intel IPP Performance Gain over  
Optimized C Code



Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, reference [www.intel.com](http://www.intel.com) or call (U.S.) 1-800-628-8686 or 1-916-356-3104.



# Intel® Cluster Tools

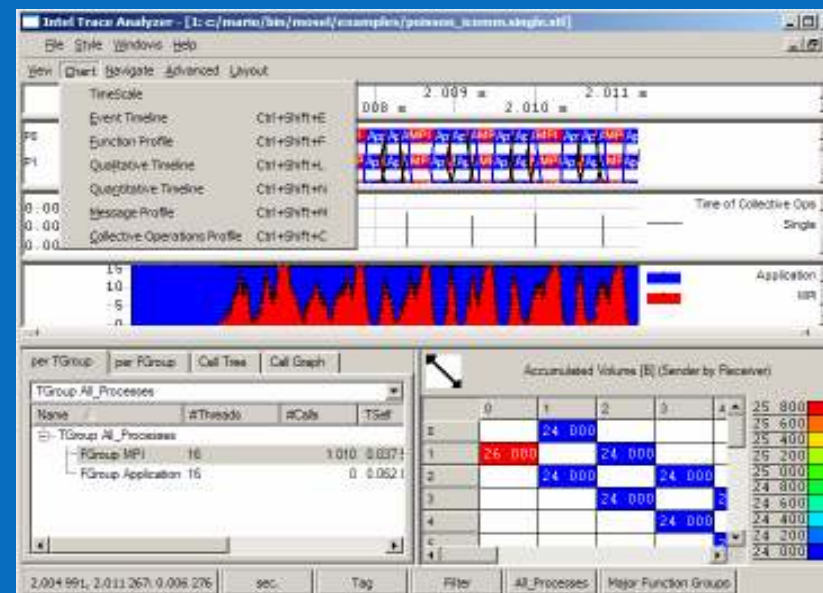
Boost cluster application's development and performance

- Create, analyze, optimize and deploy parallel applications
- Network-independent MPI library
- Ready for multi-core cluster

## Intel® Cluster Toolkit

A complete MPI tools environment

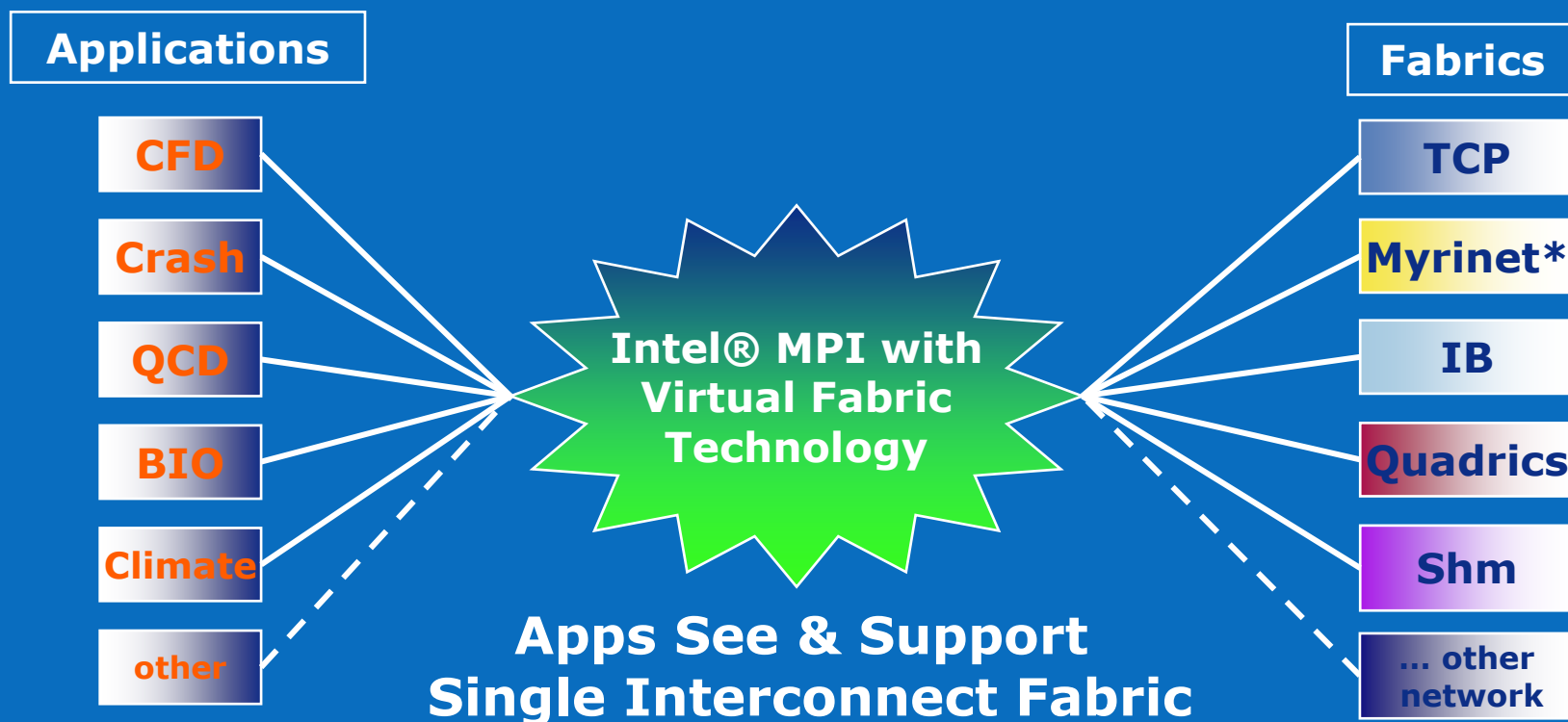
- [Details](#) – Intel® MPI Library
- [Details](#) – Intel® Trace Analyzer and Collector
  - Intel® MKL Cluster Edition
  - Intel® MPI Benchmarks



**New GUI with  
Trace Analyzer and Collector 6.0**



# Intel® MPI Library: A Simpler Solution



**Gives Flexibility to Choose the Best Interconnect Fabric  
With No Code Changes to Application Software**

# Cluster OpenMP\*

Runs (slightly modified) OpenMP codes on a commodity cluster

- No need to explode your code and rewrite it in MPI
- Exploit existing OpenMP codes which run on SMP machines on cheaper clusters
- Supports C, C++ and Fortran
- Available as a product now
  - Licensed (at extra cost) with the Intel 9.1 compilers for IPF and EM64T machines running Linux

Suitable Programs:

- Programs that scale successfully with OpenMP on SMP
- Programs that have good data locality
- Programs that use synchronization sparingly



# Cluster OpenMP\*

Only one new statement “`sharable`” is required

- Used at the declaration (or allocation) point of variables which are shared between threads
- In many cases the compiler can deduce the need for a sharable qualification and introduce it automatically
- As with OpenMP you still have a valid serial code after porting
- For SpecOMP\* codes only about 2% of source lines needed to be changed. The largest code (FMA3D, ~60,000 lines) needed no source code changes at all.

For suitable codes performance can match (or even exceed) that of the same code in OpenMP on an SMP machine with the same number of CPUs

Intel Cluster OpenMP is the only commercially available OpenMP system for clusters.





## Intel® Premier Support

**"Registering for support was easy, and we value the security of knowing that Intel is there to help, even though we haven't needed it so far."**

*— Rob Hoffmann - Director of Marketing, NewTek, Inc.*

Purchase of Intel® Software Development Products includes one year of unlimited premier support

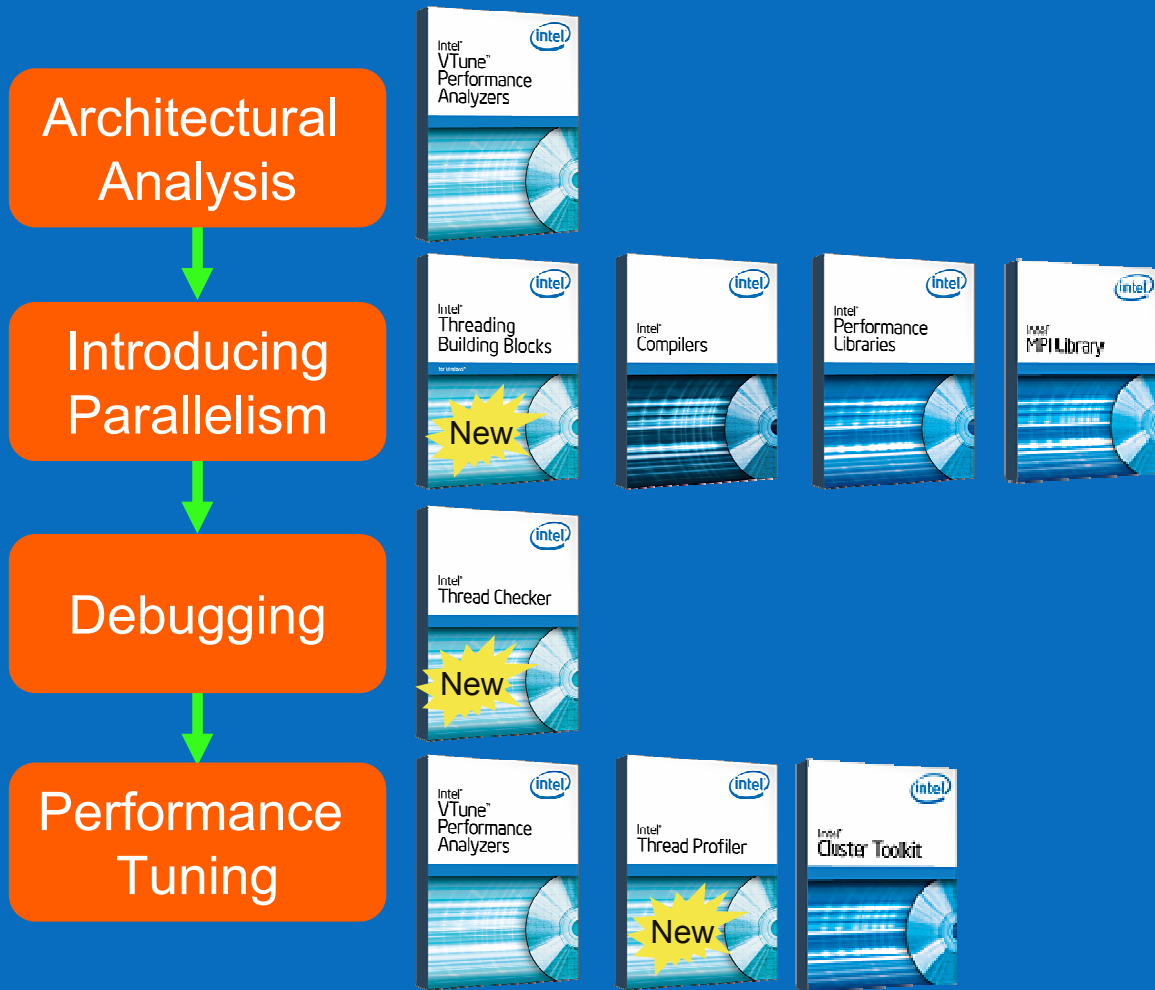
Intel® Premier Support includes:

- Primary support for all Intel Software Development Products
- Online access to Intel Premier Support Website
- Issue submission & tracking
- Product updates & related downloads
- FAQ's, user forums, & other proactive notices

**Support Comes Directly from  
Experts in Software Development at Intel**



# Comprehensive, industry leading solutions for parallelized software development





# Conclusion and Next Steps

## Intel® Software Development Products

**The products you need  
to develop parallel applications**

- Architect, introduce, debug and tune parallel programming including multi-threading & MPI clusters
- Supports existing build process
- Source & binary compatible
- Cross hardware and OS platform support

**Next Steps: Try the products ...**

**Learn more and download evals at:  
[www.intel.com/software/products](http://www.intel.com/software/products)**





Remember when  
the sky was the limit?

# THANK YOU! QUESTIONS?





Remember when  
the sky was the limit?

## Backup



# Intel® C++ Compilers for Embedded IA

- Compilers based on Intel® C++ Compilers for desktop/server markets\*\*
  - Leverage mature Intel Compiler technology
- Superior performance
  - Leading industry support with Intel Architecture performance features and multi-core
- Cross-compiling capability
- Support for Embedded Operating Systems:
  - Wind River Linux\* PNE-LE
  - MontaVista Linux\* CGE
  - QNX Neutrino\* RTOS
- Integration into embedded cross-development environments
- GCC C/C++ Object compatibility and interoperability
- Bi-Endian support for architectural migration



# Intel® Compiler / Debugger Tools for Intel XScale® Microarchitecture

- Intel® C++ Software Development Tool Suite For Intel XScale® Microarchitecture, Professional
  - Compiler system & set of debuggers
  - Suited for system and board bring-up software development
- Intel® C++ Compiler For Windows\* CE, Professional & Standard
  - Plug and play solution for Microsoft\* Development Environment
  - Provides a significant performance boost to system and application software



# Intel® Integrated Performance Primitives (Intel® IPP)

A C/C++ library of highly optimized functions for multimedia, signal processing, speech, data compression, encryption and more

High performance library functions deliver outstanding performance on multiple platforms and let you focus on value-added application features

## Function Domains

- Image processing
- Video coding
- Computer vision
- Signal processing
- Data compression
- Image color conversion
- Audio coding
- String/Regex operations
- Matrix math operations
- Cryptography
- JPEG/JPEG2000
- Speech coding
- Speech recognition
- Vector math operations

## Features

- Over 50 code samples illustrating library usage
  - including advanced video, audio, and speech codecs
- Intel IPP book from Intel Press available
- Free non-commercial Linux\* licenses

- ☑ Windows\*
- ☑ Mac OS\* - New!
- ☑ Linux\*

- ☑ IA-32 Intel® Architecture
- ☑ Intel® EM64T
- ☑ Intel® Itanium® 2
- ☑ Intel® XScale™

**Multi-Core Performance for Multimedia  
and Data Processing Applications**



# Intel® Trace Analyzer and Collector

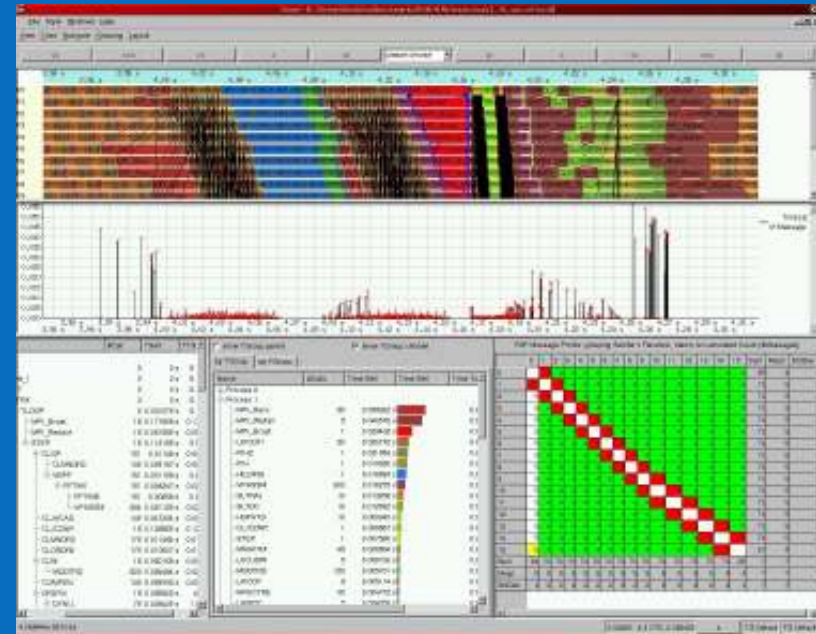
Analyze MPI distributed-memory applications to help optimize message passing performance

- Works with threads, too
- Supports multi-core platforms

Intel® Trace Analyzer and Collector

- Collect detailed runtime data
- Supports MPI, Java® RMI and socket communication
- Emphasizes scalability in time and cores/CPUs
- Graphical analysis of app execution and performance
- Combines statistics and detailed event displays

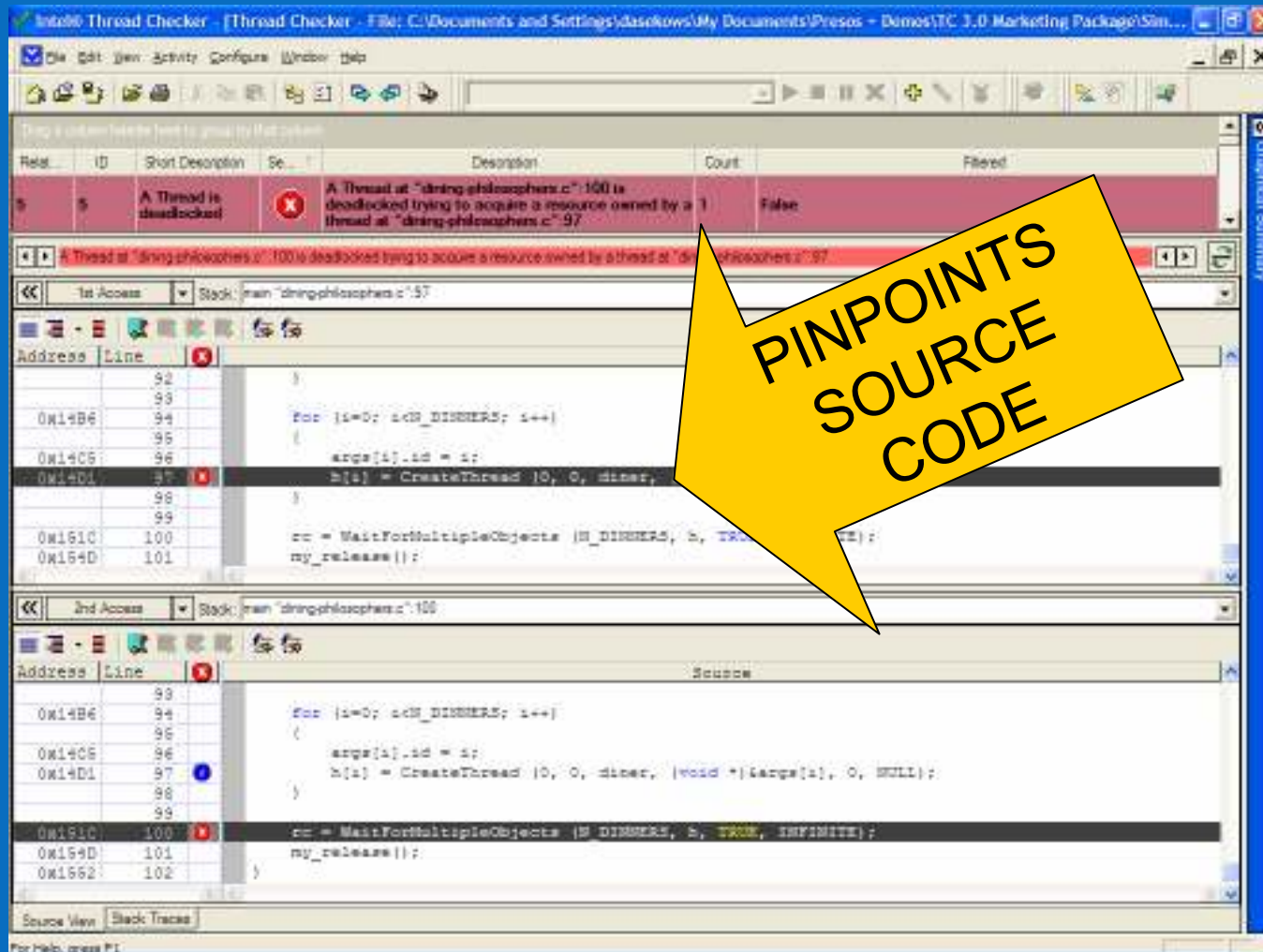
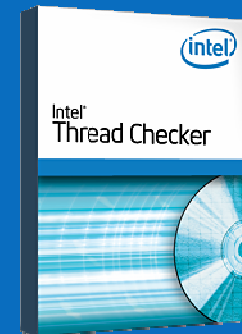
Analysis tools simplify and speed up parallel software development for clusters





# Intel® Thread Checker for Windows\*

## Pinpoints notorious threading bugs





# Intel® Thread Profiler

## Pinpoints threading inefficiencies

